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Design on a method for interactive editing fault polygon

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Abstract

This paper presents an interactive graphic editing method based on a new designed logical storage structure, of which the flexibility greatly improves not only the performance of fault polygons interactive editing, but also the appearance and the visual effect of fault polygons. Therefore, it can provide a proper way for the seismic data interpretation. Through the verification of seismic images of Daqing oil fields, this interactive editing method effectively improves the deficiencies of fault polygon automatic extraction , meanwhile it further increases the accuracy of fault polygon interpretation.

Key words: fault polygon editing; graphic storage structure;seismic images;seismic data interpretation

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Introduction

With the continuous deepening of oil field exploration and development, the demand of seismic data interpretation accuracy has become increasingly demanding. Therefore, on the basis of automatic interpretation, improving the accuracy of seismic interpretation further is the direction of technology development. In the process of interpretation, the fault interpretation is the key point. Currently, many automatic extraction methods exist in fault polygons extraction. However, due to the extreme complexity of the faults, these methods are often not able to fully meet the requirements of the actual shapes of the faults, and more or less, there must be some certain errors to the actual fault areas, affecting the accuracy of constructing images. Therefore, this paper deeply studies the lack of automatic extraction of fault polygons, and proposed an interactive editing method which is based on a new designed logical storage structure. The experiments show, this method can not only meet the requirements of interactive editing fault polygons very well, but greatly improve the accuracy of seismic data interpretation. So this method can be applied widely.

The purposes of this interactive editing method are as follows:

1) To improve flexibility of interactive editing.

2) To improve the performance of adding, deleting and moving operation.

3) Retain the data format characteristics of the original fault polygons when the editing is completed.

4) To further improve the accuracy of the interpretation, as well as the appearance and visual effects of fault polygons.

1. Graphics logical storage structure designing

1.1. Design requirements

Usually, the element nodes of a data structure are dynamic. According to requirement or in the process, a new node can be added(called insert operation) and an existed node be deleted(called delete operation)in a data structure. The nodes in a data structure are in order, so when the original sequence needs to be changed in the operation, it requires a node be moved to a new location.

Based on the acknowledge of data structure above as well as deep research on fault polygon data, it requires storage structure of fault polygon in this system follow some rules below:

1）Graphics storage structure designing can improve flexibility when editing each base element which constitutes fault polygon.

2）When editing every base element of polygon, it must guarantee the geometry information and attribute information of each one.

3）Selecting each base element can fast locate the memory address and accelerate refresh rate.

1.2. Structure characteristics

The point of a good graphical editing system is the graphic storage structure, and a good graphic storage structure can greatly improve the flexibility of interactive editing operations. However, some traditional graphic storage structure can not satisfy the characteristics of fault polygon data format.

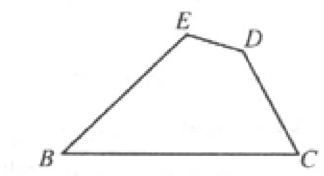


Fig.1.2.1 traditional polygon structure

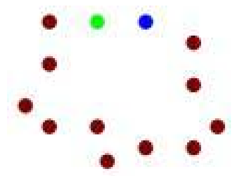


Fig.1.2.2 fault point of fault polygon

Fig.1.2.1 shows points A, B, C, D are without their own attributes in traditional polygon, only with geometry information. It is just that polygon ABCD contains attribute information.

Fault polygon files are some sets of scatter points, as shown in Fig.1.2.2. All points of the fault polygon are linked together in order.

Fault point data is classified by its location as follows:

1)● the first point of polygon, represented by number 6 in fault polygon file.
2)● the middle point of polygon, represented by number 7 in fault polygon file.
3)● the last point of polygon, represented by number 8 in fault polygon file.

Every point contains both geometry information and attributes. Meanwhile its original attributes should be kept after being edited.

1.3. Designing Result

To the characteristics of fault polygon, a kind of graphic data storage structure is designed for fault polygon to interactively edit. The specific structure is achieved as follows:

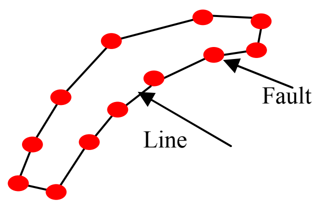
1） data structure of fault point:

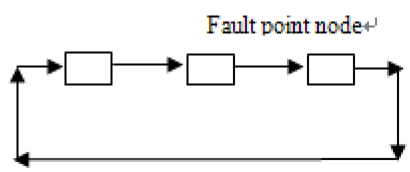
```
Struct FaultPoint{
    PointID;
    double CDP;              //road number
    double LineNO;           //line number
    double X;                //geodetic coordinate X
    double Y;                // geodetic coordinate Y
    int flag;                //fault point type flag
    int PolygonPos;          //polygon mark
    int posInpolygon;        //position in the polygon
    QSet<Line *>myLines;     //line set connected with fault point
    Other attributes}
```

2） line structure

LineID	FirstPoint(the first point)	lastPoint(the second point)

3） polygon structure





Every fault point of the fault polygon stores the information of its two adjacent lines, and every line stores the information of its two endpoints. The benefits are as follows:

1）While the points and lines are stored separately, the polygon is whole when showed.

2）Original fault point attributes information can be kept well.

3）Its adjacent lines information could be located when some fault point is selected, improving editing operation greatly.

2. Graphic Interactive Editing Method

2.1. Adding Nodes

When the distance of two nodes, such as line AB in Fig.2.1.1, is over certain distance, it seems not smooth enough, which can not meet the demand of interpretation personnel, and even affects the accuracy of fault polygon interpretation. Then one or more points need to be added during A and B, shown as point C in Fig.2.1.2.

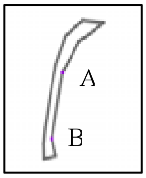


Fig.2.1.1

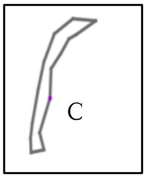


Fig.2.1.2

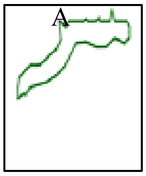


Fig.2.2.1

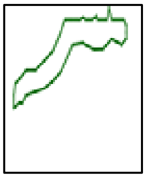


Fig.2.2.2

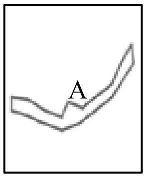


Fig.2.3.1

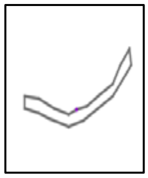


Fig.2.3.2

Specific adding nodes steps:

Step1: make sure the location of point is added; select its precursor node and descendant node.

Step2: judge the sum of two nodes' flag.

Step3: if the sum equals to 14, then we can know that the selected two nodes exist in two circumstances：

1）One is the first node and the other is the last. The new nodes are inserted into the end of list, afterwards change flag to 8 and change “posInpolygon”.

2）Both are the middle nodes. The new node is inserted into them, set flag to 7, and change “posInpolygon”.

Step4：If the sum of flag is 13,then one of the two nodes selected is the first node and the other is the second. Insert the new node directly back of the first node, and then set flag to 7, at the same time change “posInpolygon”.

Step5: If the sum of flag is 15, then one of the two nodes selected is the last node and the other is the penultimate node. Insert the new node directly back of the node whose flag is 7, then set flag to 7, at the same time change “posInpolygon”

2.2. delete node

Point A shown in Fig.2.2.1 is seen as an irregular polygon point in the fault polygon. If the length of the two lines whose vertex for A is less than 6 pixels, and angle A is less than 60°,then remove point A, the removing result is shown as Fig.2.2.2.

the deleting steps:

Step1: Select the node you want to delete.

Step2: If the flag value of node is 6, delete it, then the flag of its descendant node is set to 6, then reset the connection of lines.

Step3: If the value is 7, delete it directly, then reset the connection of lines.

Step4: If the value is 8, delete it, the flag of its precursor node is set to 8, and then reset the connection of lines.

2.3. move node

Point A shown in Fig.2.3.1 is seen as an irregular polygon point in the fault polygon. If the length of the two lines whose vertex for A is more than 6 pixels, and angle A is more than 60°, then move point A to a new location you need, the result is shown as Fig.2.3.2.

the moving steps:

Step1: Select the node you want to move.

Step2: If the flag value of node is 6, then it proves that the precursor node is the last node, move it and reset the connection of lines.

Step3: If the value is 7, then get the precursor and descendant node directly,and reset the connection of lines.

Step4: If the value is 8, then it proves that the descendant node is the first node, reset the connection of lines.

Based on the design of interactive editing method of new data structures, the system is also combined with the feature of QT Development Environment. Ordinary QWidget interface graphics management in QT Development Environment is not used any more. Instead, the QGraphicsView(control viewer for display graphics) is used to display and managed by QGraphicsScene（control Graphic elements of container）. Divide polygon into points and lines, and show them in QgraphicsScene. Fault point element is a new class which inherited QGrahicsItem class (Graphic elements of base class). Line element also inherited QGrahicsItem (Graphic elements of base class) class.

From what is said above, now we have designed a set of interactive editing system which is suitable for fault polygon. At the same time the speed of interactive editing process also becomes faster than the traditional method. Thereby, it greatly improves the efficiency of the interpretation.

3. Application

In this paper, we did simulation experiment for the seismic images of many blocks in Daqing oil fields. Due to the limited space, certain blocks of Daqing oil fields are used as an example, giving a comparison result the fault polygon edited before and after. Fig.3.1 and Fig.3.2 separately are fault polygons extracted and fault polygons after being edited for a certain block in Daqing oil fields.

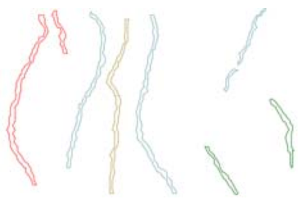


Fig.3.1 fault polygons extracted

Fig.3.2 Fault polygons after editing

4. Conclusion

This paper researched fault polygon interactive editing method for further, based on the analysis of the traditional graphical interactive editing method and fault polygon data, finally, start from changing graphics storage structure. The method of graph editing in this paper has been used in many blocks in Daqing oil fields, and we have done many experiments. These experiments show that the editing method this paper mentioned, not only retained the characteristics of the original fault polygon data , but also improved the accuracy of the fault polygon information for further, and satisfied the requirements of the interpreter much better. So it can greatly improve the accuracy and efficiency of seismic interpretation.

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